Figure 1A

Figure 1B

Figure 2

Figure 3

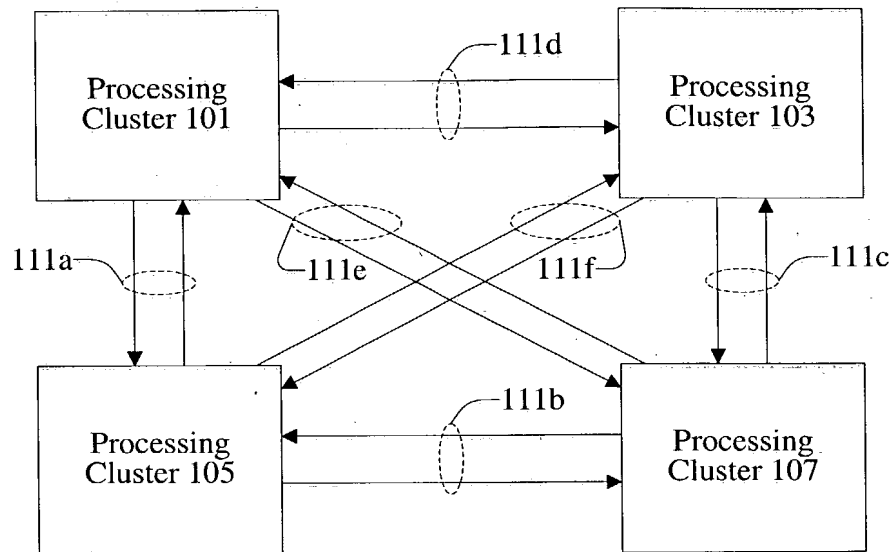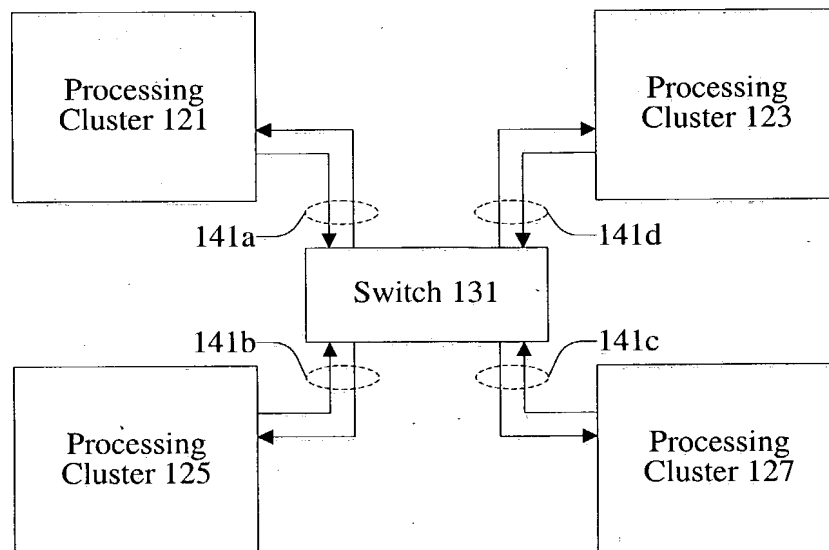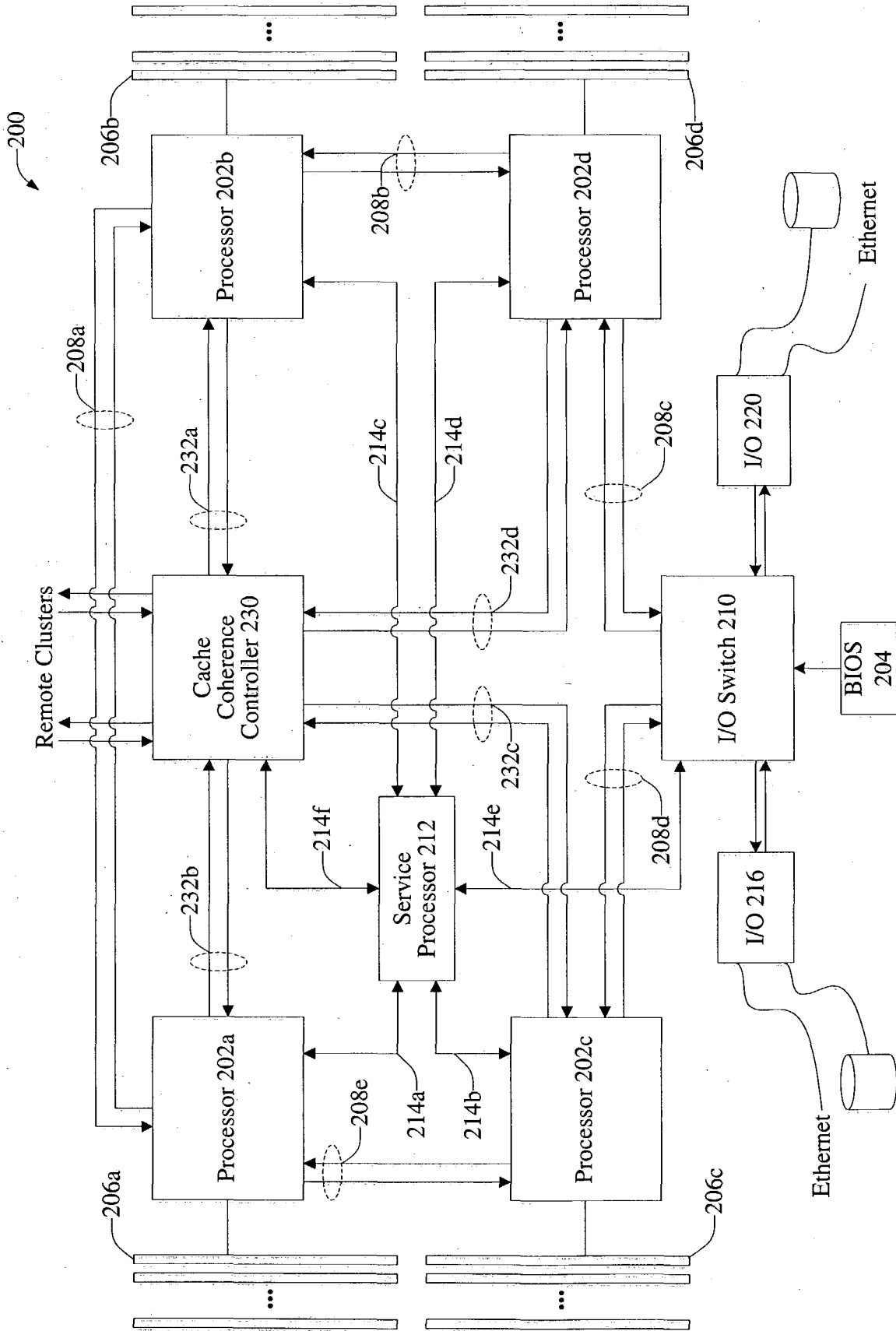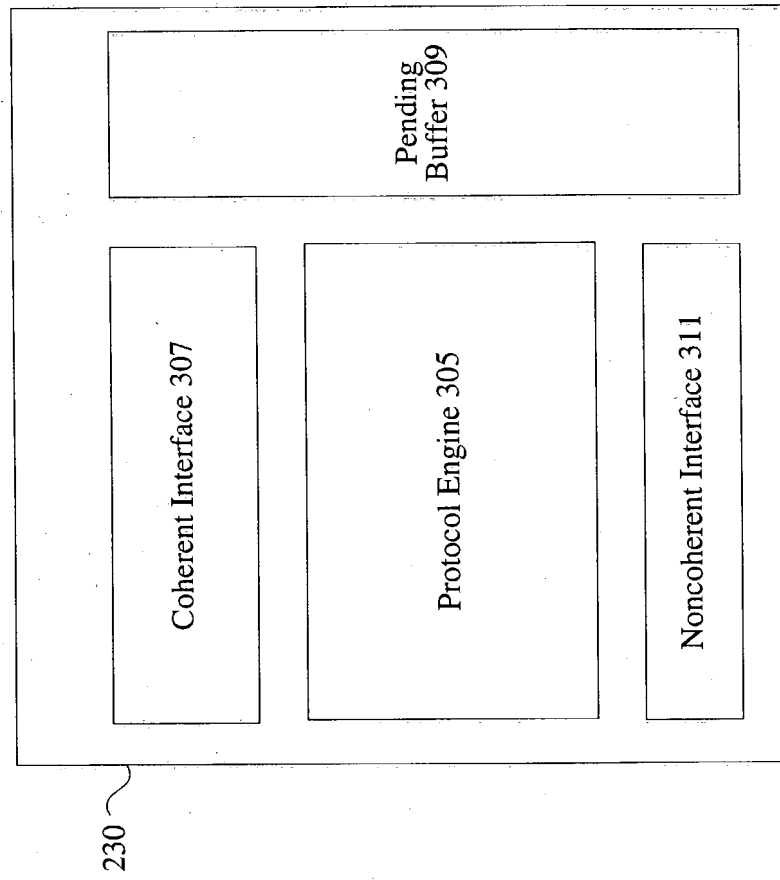Coherent Interface 307

Protocol Engine 305

Noncoherent Interface 311

Pending
Buffer 309

230
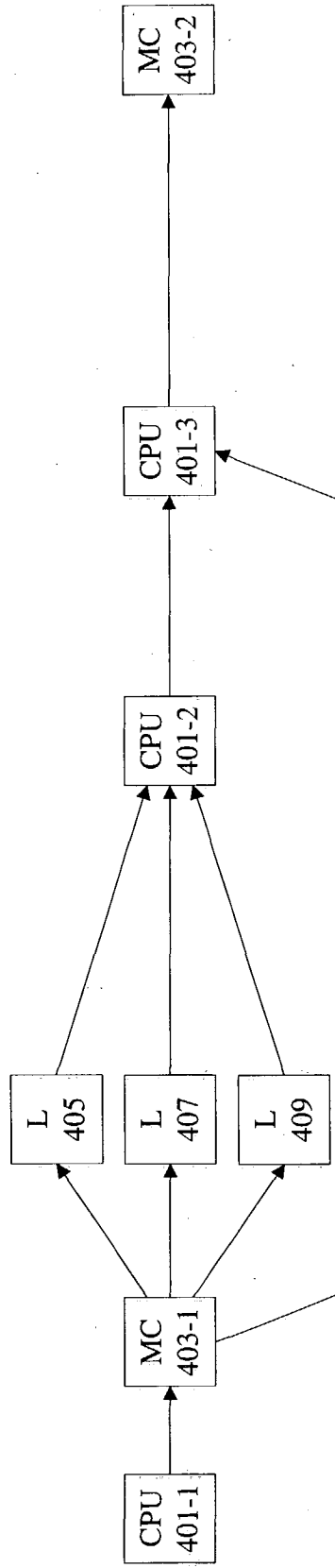
Figure 4

Figure 5A

Figure 5B

Figure 5C

CPU
541-1

C
543-1

L
545

L
547

L
549

L
551

CPU
541-2

CPU
541-3

C
543-2

Non-Local Nodes
553

Figure 5D

Figure 6

CPU
601-1

C
603-1

L
605

L
607

L
609

CPU
601-2

C
603-2

C
603-3

CPU
601-3

C
603-4

CPU
601-4

C
603-5

Request
Cluster 600

C
621-1

MC
623-1

L
625

L
627

C
621-2

C
621-3

C
621-4

C
621-5

MC
623-2

Home
Cluster 620

C
641-1

L
645

L
647

L
649

C
641-2

Remote
Cluster 640
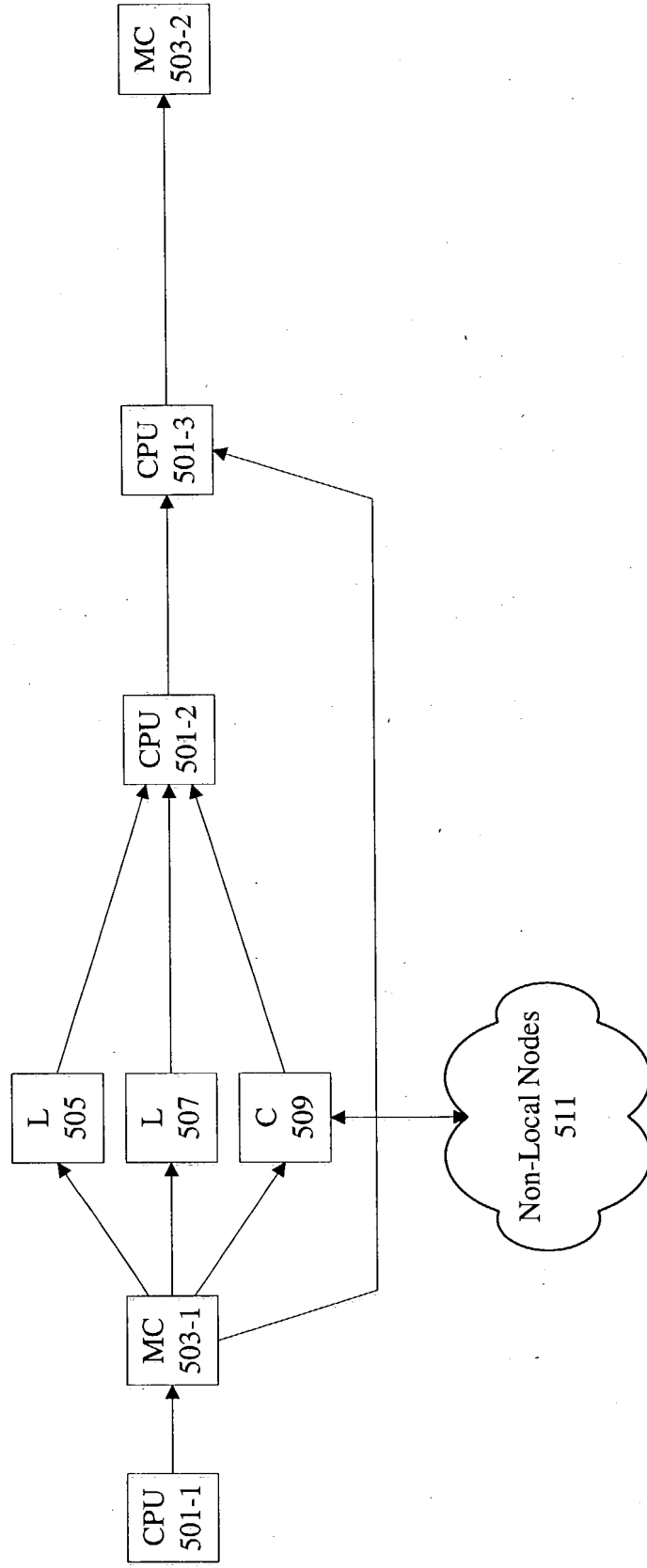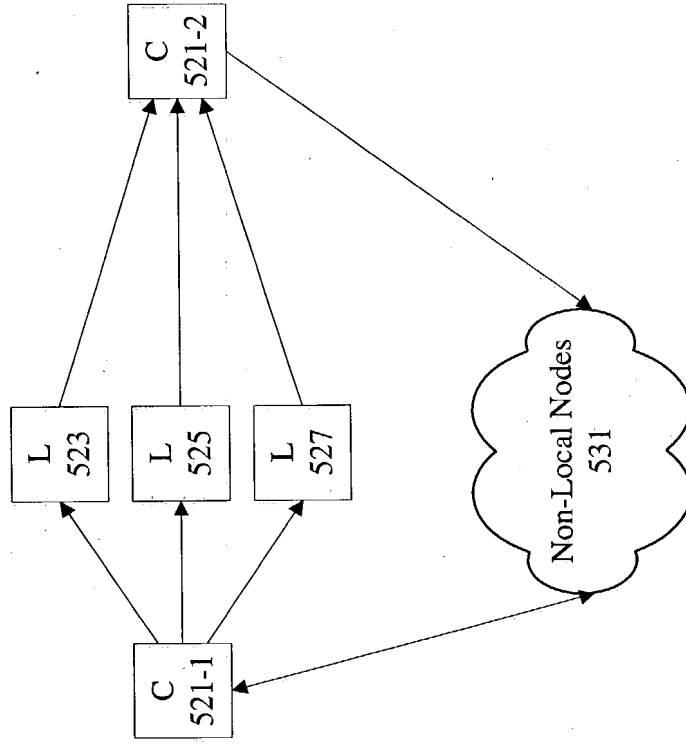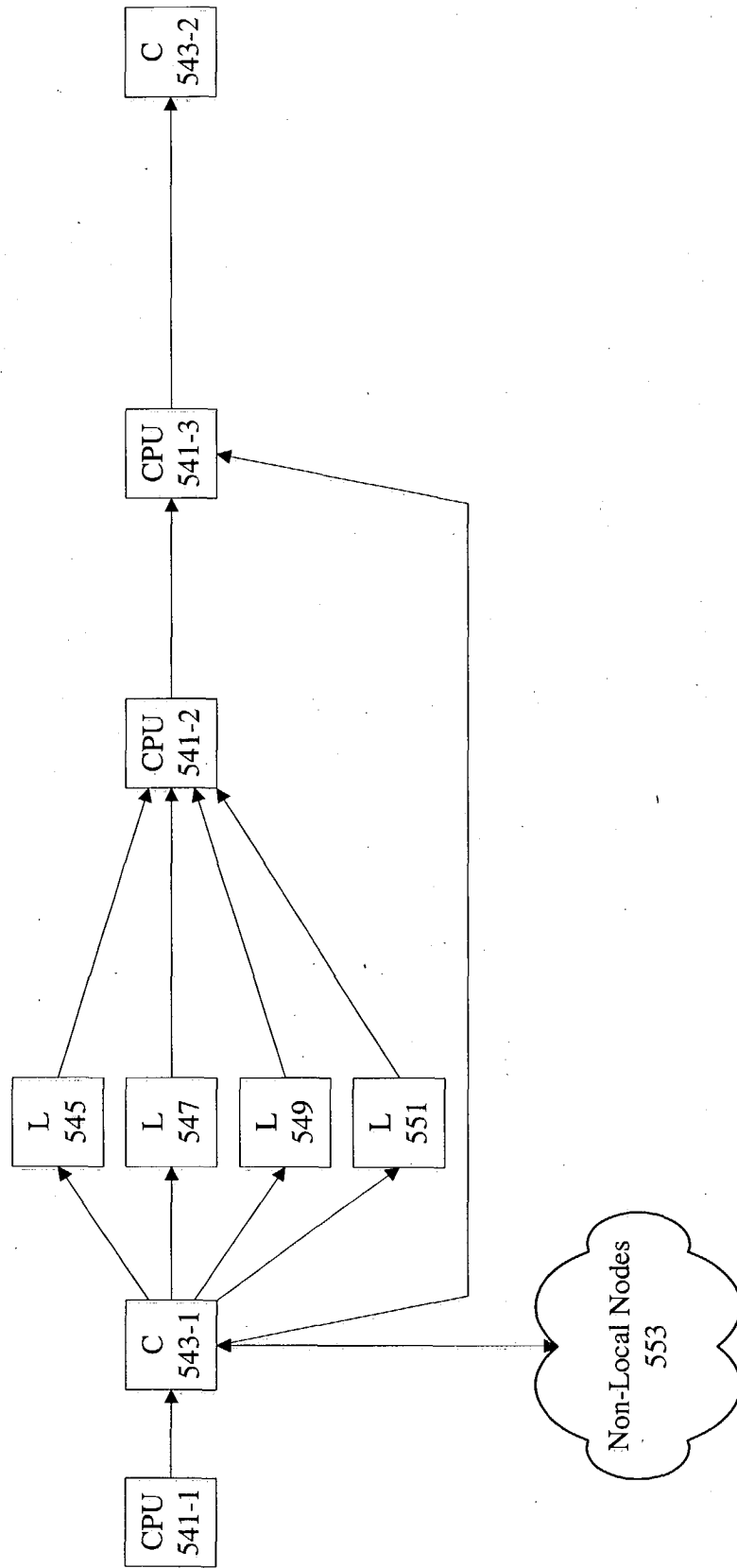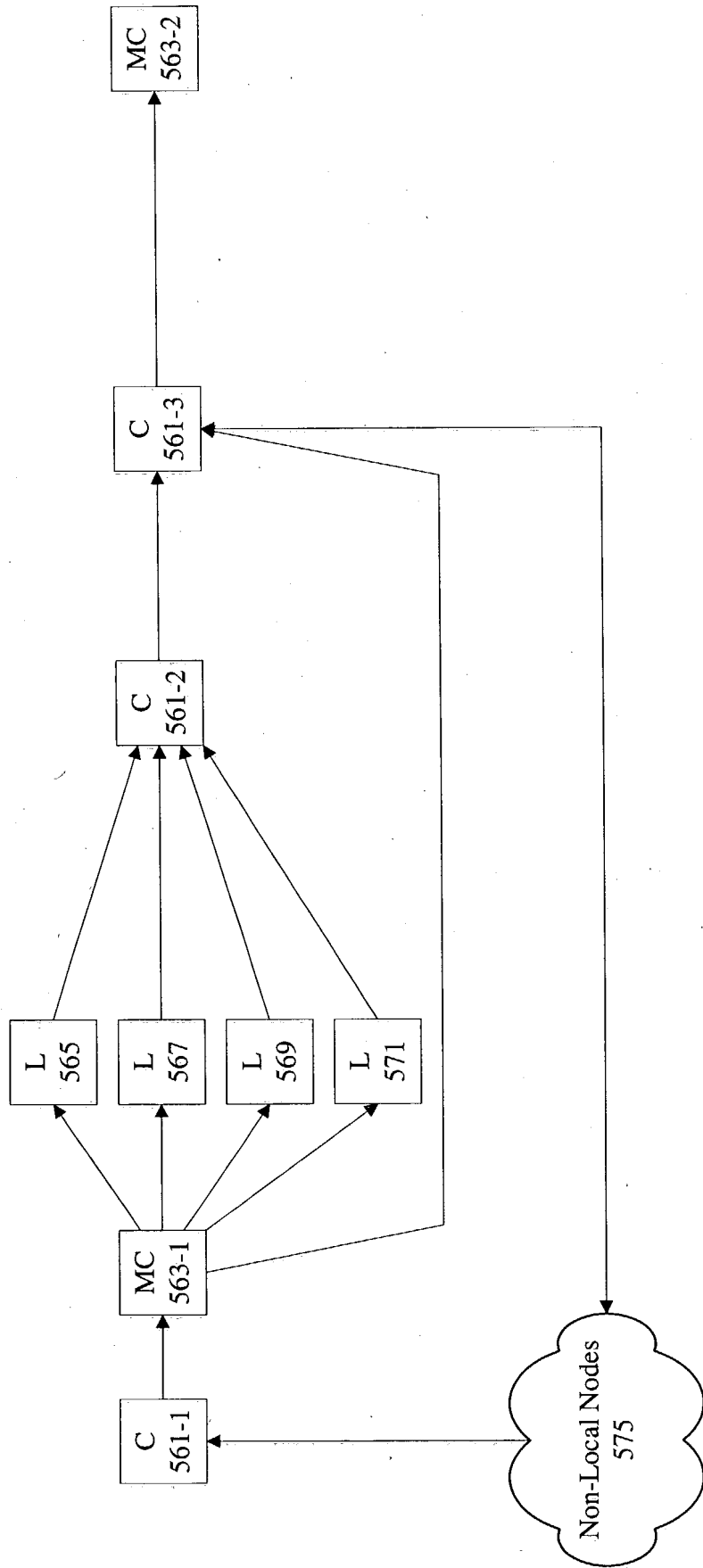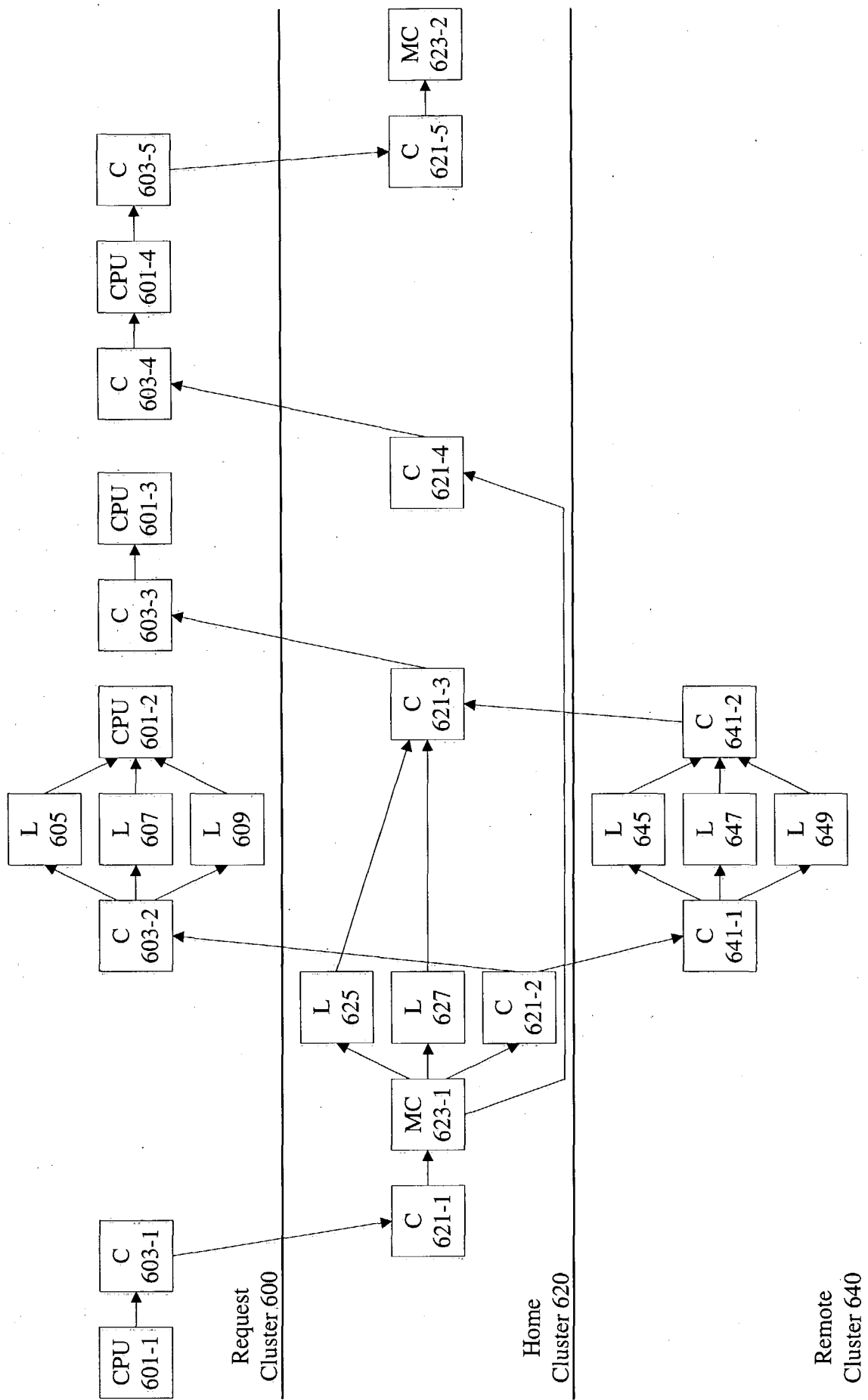
Figure 7

Coherence Directory 701			
Memory Line 711	State 713	Dirty Data Owner 715	Occupancy Vector 717
Address 721	Invalid	N/A	N/A
Address 731	Invalid	N/A	N/A
Address 741	Shared	N/A	Clusters 1,3
Address 751	Shared	N/A	Clusters 1, 2, 3, 4
Address 761	Owned	Cluster 4	Cluster 2, 3, 4
Address 771	Owned	Cluster 2	Cluster 2, 4
Address 781	Modified	Cluster 2	N/A
Address 791	Modified	Cluster 3	N/A
...	...	...	...

Figure 8

Coherence Directory 801				
Memory Line 811	State 813	Owning Cluster 815	Owning Node 817	Occupancy Vector 819
Address 821	Invalid	N/A	N/A	N/A
Address 831	Invalid	N/A	N/A	N/A
Address 841	Shared	N/A	N/A	Clusters 1,3
Address 851	Shared	N/A	N/A	Clusters 1, 2, 3, 4
Address 861	Owned	Cluster 4	Node 2	Cluster 2, 3, 4
Address 871	Owned	Cluster 2	Node 3	Cluster 2, 4
Address 881	Modified	Cluster 2	Node 1	N/A
Address 891	Modified	Cluster 3	Node 3	N/A
...	...	...	...	...

Figure 9

Figure 10
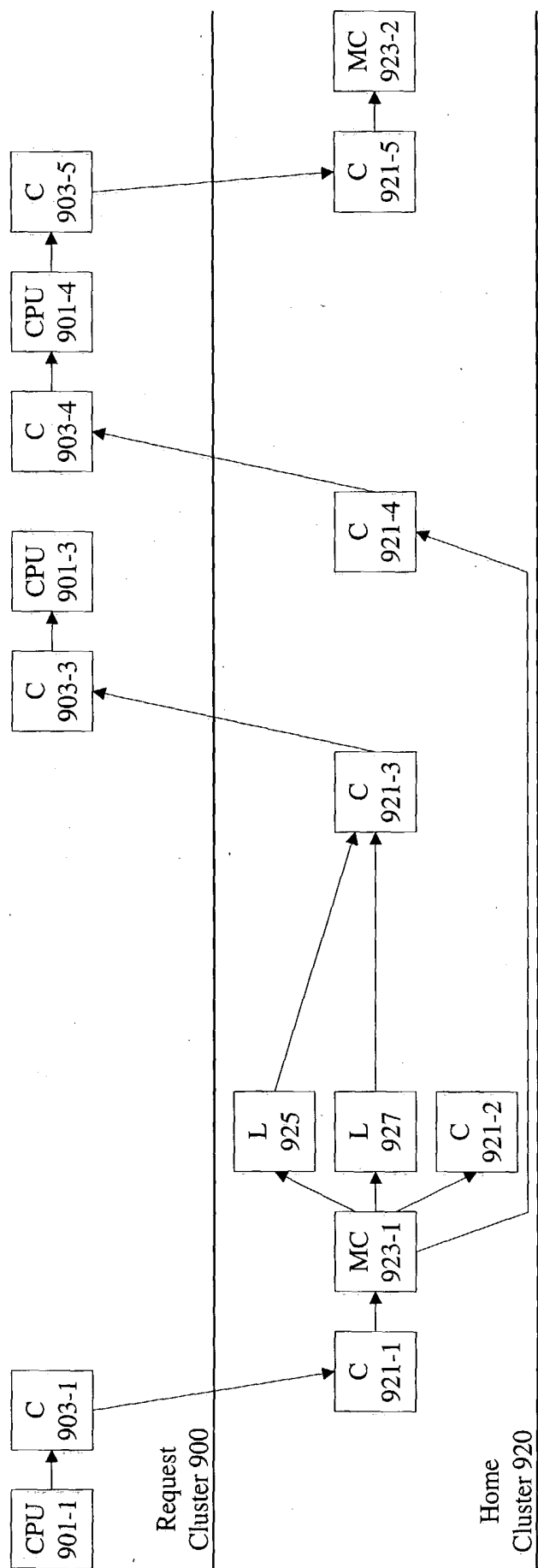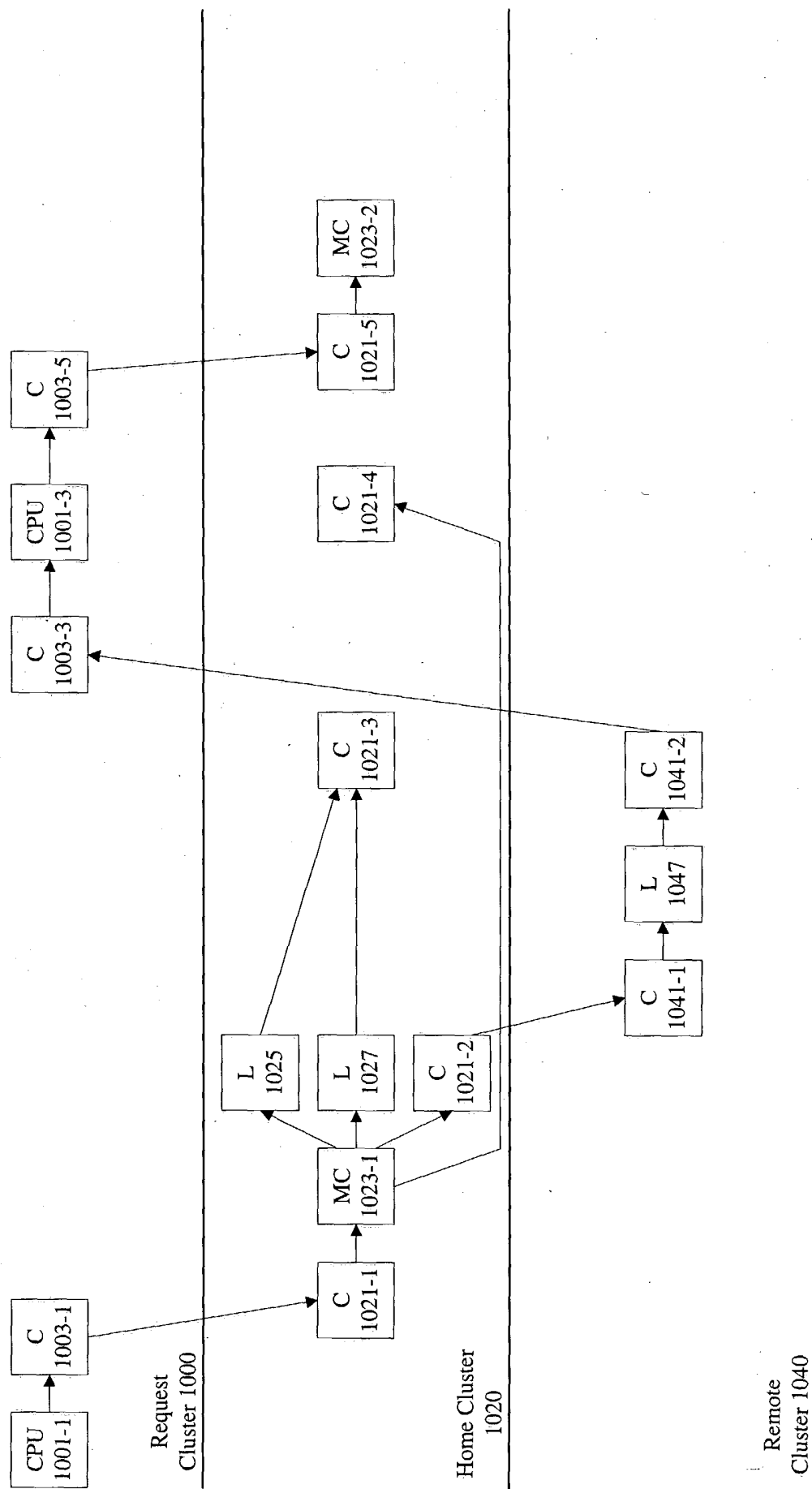
CPU
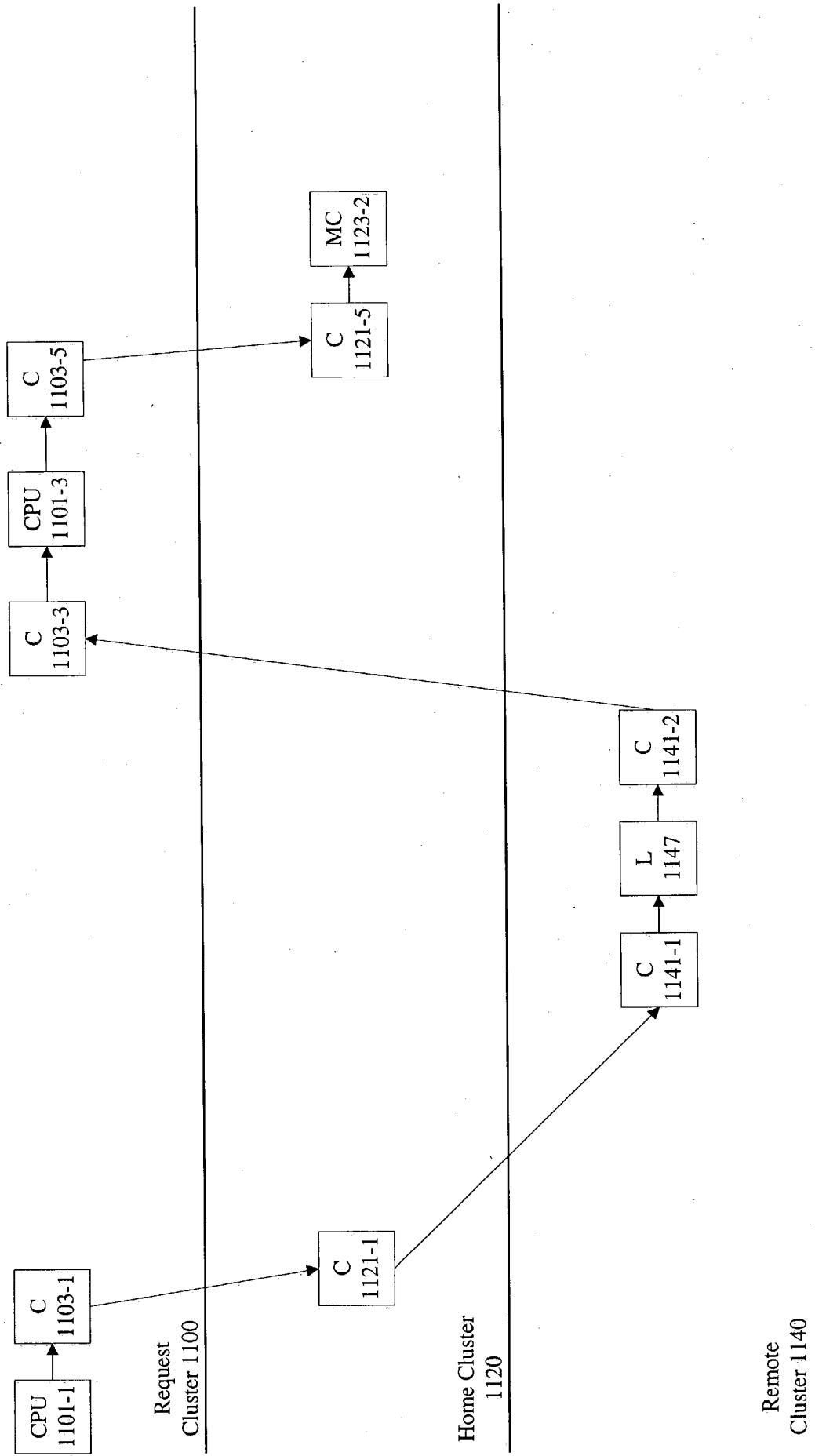1001-1

C
1003-1

C
1003-3

CPU
1001-3

C
1003-5

Request
Cluster 1000

C
1021-1

MC
1023-1

L
1025

L
1027

C
1021-2

C
1021-3

C
1021-4

C
1021-5

MC
1023-2

Home Cluster
1020

C
1041-1

L
1047

C
1041-2

Remote
Cluster 1040

Figure 11

Figure 12

```
        ┌─────────────────────────┐
        │      Probe Request      │
        │   Handling At Remote    │
        │  Coherence Controller   │
        └─────────────────────────┘
                    │
                    ▼
1201 ┌─────────────────────────┐
     │  Receive Probe Associated │
     │    With A Memory Line     │
     │     From Home Cluster     │
     └─────────────────────────┘
                    │
                    ▼
1205 ┌─────────────────────────┐
     │   Identify Owning Node    │
     │    From Information In     │
     │          Probe            │
     └─────────────────────────┘
                    │
                    ▼
1209 ┌─────────────────────────┐
     │   Probe Only The Owning   │
     │          Node             │
     └─────────────────────────┘
                    │
                    ▼
1213 ┌─────────────────────────┐
     │   Receive Response From   │
     │       Owning Node         │
     └─────────────────────────┘
                    │
                    ▼
1217 ┌─────────────────────────┐
     │   Forward Response To     │
     │      Request Cluster      │
     └─────────────────────────┘
                    │
                    ▼
               ┌────────┐
               │  End   │
               └────────┘
```